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MANUAL FOR SPEED VIOLATION DETECTION SYSTEM

INDIAN ROADS CONGRESS
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ABBREVIATIONS

CCTV	Closed Circuit Television
GSM	Global System for Mobile
HSRP	High Security Registration Plate
ITS	Intelligent Transport System
IP	Ingress Protection
IR	Infra-Red
LIDAR	Light Detection and Ranging
NCRB	National Crime Records Bureau
OCR	Optical Character Recognition
OFC	Optic Fibre Cable
OEM	Original Equipment Manufacturer
PoC	Proof of Concept
RADAR	Radio Detection and Ranging
SEB	State Electricity Board
SVDS	Speed Violation Detection System
VMS	Variable Message Sign

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3	Secretary General, Indian Roads Congress	(Nirmal, S.K.)

1. INTRODUCTION

The Manual has been prepared in pursuance to the first meeting of the Intelligent Transportation Systems Committee (G-7) held in September 2021 and subsequent review meetings. As this Manual is first of its kind in IRC with an immense value towards enhancing road safety using ITS, accordingly, the work of preparation of new document on "Manual of Speed Violation Detection System" was taken up by the Intelligent Transportation System Committee (G-7) during its tenure 2021-2023 under the convenorship of Prof. (Dr.) P.K. Sarkar. The first draft of the Manual was prepared by the Sub-group comprising of Shri Puneet Singh Bindra, Convenor of the Subgroup, Dr. Chalumuri Ravisekhar, Shri Sudhir Kumar, Dr. Madhusadan Joshi and Shri Ashutosh Gautam. The draft was discussed and deliberated in a number of meetings of G-7 Committee. The draft prepared by the sub-group under the convenorship of Shri Puneet Singh Bindra, has gone through many changes from time to time so to arrive at consensus view.

This document is duly finalized by discussion and presentations in several meetings, and rigorous review held on the shared draft document. During the 7th Meeting of G-7 Committee held on 3rd September, 2022, the draft Manual was approved for submission to the GSS Committee. The list of personnel of the G-7 Committee is as under:

Sarkar, Prof. P.K. – Convenor
Velmurgan, Dr. S. – Co-Convenor
Jain, Girish – Member-Secretary

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Secretary General, IRC
(Nirmal, S.K.)

The General Specifications and Standards Committee (GSS) considered and approved the draft Manual in its meeting held on 23rd September, 2022 for placing it before Executive Committee and IRC Council. The Executive Committee in its meeting held on 7th October, 2022 considered and approved the same for placing it before the Council. The IRC Council in its 223rd Council Meeting at Lucknow (Uttar Pradesh) held on 8th October, 2022 considered and approved the "Manual for Speed Violation Detection System" for printing.

This Manual is intended to serve purpose to the ITS professionals, engineers, traffic police and various stakeholders dealing with speed enforcement measures in the road network as well as to a greater degree of road safety to all types of road users.

1.1 Background

According to National Crime Records Bureau (NCRB) India, analysis of road accidents for the year 2019 revealed that most of road accidents were due to over speeding, accounting for 59.6% of total accidents (2,60,898 out of 4,37,443 cases) which caused 86,241 deaths and injuries to 2,71,581 persons. A worldwide review of studies found that speed cameras led to a reduction of "11% to 44% for fatal and serious injury crashes". The UK Department for Transport estimated that cameras had led to a 22% reduction in personal injury collisions and 42% fewer people being killed or seriously injured at the location of camera sites. The British Medical Journal had reported that speed cameras were effective at reducing accidents and injuries in their vicinity and recommended wider deployment. A London School of Economics study in 2017 found that "adding another 1,000 cameras to British roads could save up to 190 lives annually, reduce up to 1,130 collisions and mitigate 330 serious injuries." A four-year evaluation report of data collected in Britain, published in 2005, looked at 2,000 sites (urban and rural, using fixed and mobile cameras) where speed measurements were taken both before and after camera deployment. Analysis showed that once the cameras were operational, there was a substantial improvement in compliance with speed limits; a particular reduction in extreme speeding and a marked reduction in average speed at fixed sites.

1.2 Purpose of Preparing of Manual for Speed Violation Detection System

The primary purpose of this document is to serve the ITS professionals, practicing engineers, traffic police and various stakeholders dealing with speed enforcement and management measures for safety to the road network as well as to enhancing a greater degree of road safety to all types of road users. This Manual is produced as an outcome out of a number of deliberations and discussions and observations made in the, ITS Committee (G-7). Every attempt has been made to address the relevant problems and issues for renforcing speed limits for different types of roads and highways. It is hoped that this Manual will find its immense usefulness in ensuring orderly and safe movement of traffic on the road in the present as well as future smart cities

Based on a number of studies carried out in developed countries for reduction of road accidents using speed cameras, the following are the results observed after the implementation of speed cameras:

- Deployment of speed cameras leads to appreciable reductions in speed in the vicinity of the cameras, and substantial reductions in collisions and casualties at those locations.
- Clear and sustained falls in the average speeds of cars.
- Public acceptance of cameras was widespread.
- Increases in speeds and speeding at various sites where cameras were visibly out of action

- Significant falls in fatal or serious casualties at camera sites have persisted over time.
- National decommissioning of cameras could result in about 800 extra people across Great Britain being killed or seriously injured each year.
- The benefit/cost ratio of camera enforcement was about 2:3.
- Cost of camera enforcement was being covered by penalties paid by detected offenders, with only a modest surplus to the Exchequer of less than 10% of the penalty paid.

Further studies in measuring effectiveness of speed cameras are needed.

1.3 Need to Avoid the Present Manual Based System due to of Various Constraints.

In India, in the past, speed enforcement has been carried out by traffic police personnel by random spot checks using hand-held speed measurement guns. These RADAR guns measure the vehicle speed based on RADAR system. The over-speeding vehicle is manually stopped and penalised.

This method is severely constrained by lack of personnel. Also, since the vehicles are stopped, the process of enforcing overspreading/under-speeding of vehicles throughput is very low, it results in inconvenience to other users and it alerts deviant drivers to temporarily slowdown to avoid detection.

1.4 Need for the Advanced Technology

With the advent of technology, it has become possible to automate the speed detection and imposing penalty (e-challaning) through implementation of ITS. Such ITS intervention achieves this automation through installation of speed and vehicle detection sensors on the road to automatically detect and identify over/under-speeding vehicles and generate challaning without the need to stop the vehicle. Speed Violation Detection Systems (SVDS) using Automated Speed Enforcement (ASE) systems are an important element in speed management and can be a highly effective counter measure to prevent speeding-related crashes.

However, it is a supplement to, not a replacement for, traditional enforcement operations. The automated systems are now being implemented in India on urban and inter-urban roads. Traditional manual systems have the following advantages: the driver receives immediate feedback on the violation, the Police can explain the risk of speeding to the driver (driver education); the driver may be identified as a disqualified driver or a “wanted” person and in addition, other offences may be detected e.g. checks for breath test, driver license, vehicle safety, etc. in addition to other non-traffic crimes.

Advantages of automated systems include: i) the ability to increase safety for law enforcement officers by implementing automated systems in areas where traditional traffic stops are dangerous or infeasible due to roadway design, ii) the ability to continuously enforce the speed limit (24 hours, 7 days a week), iii) reduced opportunity for corrupt behaviours to avoid a legal penalty, and reductions in traffic congestion sometimes caused by driver distraction at traffic stops or other important locations .

The following are some of the advantages and disadvantages of speed camera systems:

Table 1: Advantages and Disadvantages of Speed Violation Detection Camera

Advantages	Disadvantages
Speed cameras can cover much greater areas than manual enforcement. They can also detect and record multiple violations every minute.	The current technology generally takes a photograph of the license plate rather than a photograph of the driver, which may cause issues related to ensuring the offending driver is held accountable.
Fully automated systems do not use the already limited police resources. They also operate at locations where roadside traffic stops are dangerous or not feasible, and where traffic conditions are unsafe for police vehicles to enter the traffic stream and stop suspected offenders.	Even though the SVDS detects and notifies a large number of violations, they still need to be approved by traffic police officers at the control room.
Offenders are recorded for all over-speeding vehicles, eliminating unfair and inequitable actions.	The system can be subject to technical glitches which might cast doubt on their reliability.
If speed cameras are placed in correct locations, it leads to reduced speed and hence accidents and fatalities.	High initial capital cost, although recurring revenue from enforcement can be reinvested in system improvement and maintenance.

1.5 Who Should Use this Speed Violation Detection System

As mentioned earlier, ITS professionals, practicing engineers dealing with road safety and enforcement measure, traffic police, concerned agencies dealing with road construction, safety and management are generally entrusted with the responsibilities to ensure safe management of road network. This Manual provides the detailed guidelines of this ITS based system by demonstrating functional, operational and maintenance plan. It is therefore envisaged that the document would enable the above users to be familiarised with the system for handing this equipment on site effectively. However it is also advised that the users before they get this installed and make it operational at the site, should be required to be trained by the technical experts. The design of the layout and selection and placement of this ITS based system would require rational and scientific assessment of its effectiveness and considerable value judgement as a part of traffic engineering and safety considerations.

1.6 Legal Aspects of Speed Violation Detection System

The Motor Vehicles (Amendment) Bill, 2019 recently passed by the Parliament provides the legal backing for implementation of this ITS based system to ensure a greater degree of safety to the road users. Under this Act 112, “ No person shall drive a motor vehicle or cause or allow a motor vehicle to be driven in any public place at a speed exceeding the maximum speed or below the minimum speed fixed for the vehicle under this Act or by or under any other law for the time being in force:” It further states that “the State Government or any authority authorised on this behalf by the State Government may, if satisfied that it is necessary to restrict the speed of motor vehicles in the interest of public safety or convenience or because of the nature of any road or bridge, by notification in the Official Gazette, and by causing appropriate traffic signs to be placed or erected under **Section 116** at suitable places, fix such maximum speed limits or minimum speed limits as it thinks fit for motor vehicles or any specified class or description of motor vehicles or for motor vehicles to which a trailer is attached, either generally or in a particular area or on a particular road.

In addition to the above, the new Act also includes more laws such punishment and heavy fines with respect to drunken driving, dangerous driving along with over speeding. With a condition that penalties will be increased by 10 percent after three years.

2. SYSTEM OVERVIEW

2.1 **Objectives :** Though the primary purpose of any speed enforcement system, using SVDS, is to reduce the number of accidents, at the operational level, the SVDS shall have the following broad goals:

2.1.1 Record vehicular speed for each vehicle on the desired road section.

2.1.2 Identify the over speeding vehicles or under speeding based on the permitted speed limit of their respective category or class (e.g. truck or car).

2.1.3 Generate and record proof of violation as a legally admissible evidence.

2.1.4 Have a flexible software to meet the performance parameters and operational requirements of the User/Authority.

The User may have additional goals and objectives to the above and the SVDS shall be designed to always meet the stated goals.

2.2 **Major Components :** For achieving above stated goals, a typical Speed Violation Detection System (SVDS) has the following major components:

2.2.1 Field equipment installed on the road

a) A gantry mounted speed sensor (RADAR/LIDAR/IR/camera) to detect vehicle speed.

b) A gantry mounted camera to accurately capture vehicle number-plate and vehicle image for legally admissible proof as well as capturing vehicle class

c) A local roadside computer housed in safe place, to process the data from sensors.

d) **Software :** application software for processing & transmitting data, equipment software & firmware, operating software, database, and any other software required to meet system /functional requirements.

e) Overhead gantry for mounting the cameras and speed sensors

f) Power supply

g) Networking equipment like GSM modem, router, fibre optic cable

h) Optional items

   i) **RFID Tag Reader:** As more and more vehicles, except two and three wheelers, adopt FASTag, it may additionally be used for vehicle identification.

   ii) Additional surveillance cameras to monitor road traffic or to monitor safety of field equipment

   iii) Advisory VMS (Variable Message Sign) mounted on the gantry to display speed. These may be installed to advise the road users of their speed so that voluntary corrective action may be taken by them.

2.2.2 Back-end /Control Room Equipment

a) A back-end/remote computer to process data received from various roadside computers, provide for verification by traffic police and generate e-challans in desired format.

b) Power supply and power backup equipment

c) Printer, to print reports and, if required, challans

d) Viewing screen to view camera feeds along with software for recording and video management.

e) Software
  - Application software
  - Operating software
  - Database
  - Web browser

The software shall be able to record violations with images. These challans with images shall be integrated with VAHAN database, uploaded on relevant websites or sent by post or other means to the speed violators. The data may be shared with other agencies and stored for later analysis.

2.2.3 Speed Measurement Sensor

The system may use any one or combination of following sensors to measure speed: - RADAR, LIDAR, IR or camera. Typically, the accuracy achieved by RADAR may be in excess of 99% while that is achieved by camera is slightly less (> 97%). However this may change due to technological advances and choice of sensor shall depend on actual performance demonstrated. RADAR is suggested for applications where high accuracy is required and speed measurement is the primary purpose. Camera based measurement is suggested where slightly higher tolerance of speed measurement is acceptable and same camera is to be used for other purposes like incident detection, Red Light Violation Detection and Stop Line Violation Detection. However, the user may decide on use of any other sensor if it passes the Proof of Concept (PoC) requirements.

2.3 **Working of a Typical System :** There are two types of SVDS for enforcement covered in this Manual – Spot Control and Section Control. Hand held readers are excluded from scope of this document as they are treated as a product.

2.3.1 Spot SVDS

Such system measures the “spot” or instantaneous speed of the vehicle. The speed sensor (like RADAR) and the camera are mounted on the gantry. The vehicle speed is recorded by the speed sensor and the camera takes the vehicle and license plate image/video as shown in **Fig. 2.1**. Normally one RADAR can handle multiple lanes but one camera is required for each lane, but this may vary.

The roadside computer records the data from these sensors, matches vehicle images with respective speeds, determines vehicle category, detects over-speeding/under-speeding of vehicles and sends the data to the control room.

Normally, for space and cost optimisation, the gantries for both directions of a carriageway are co-located but this must not be the criteria for site selection. Existing gantries or structures may be used, if suitable and available.

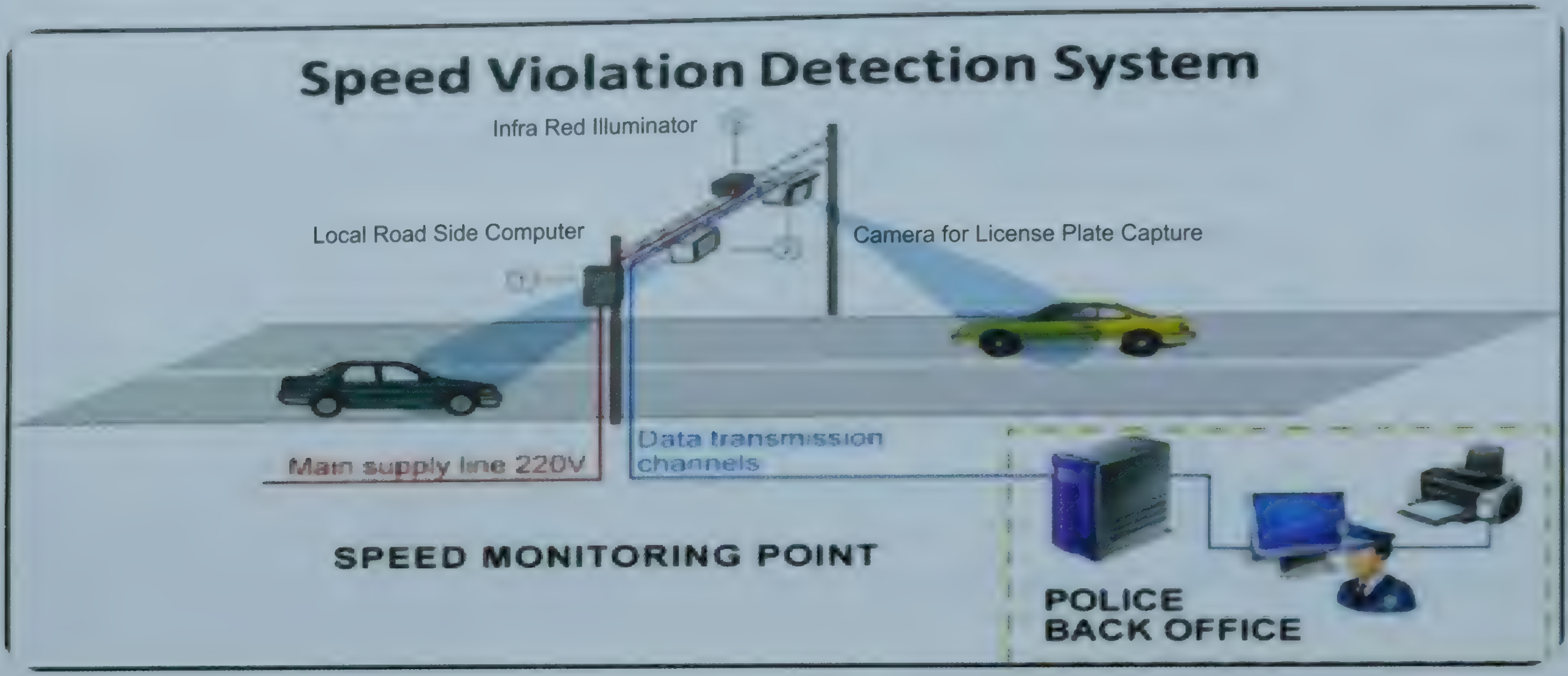

Speed Violation Detection System
Infra Red Illuminator
Local Road Side Computer
Camera for License Plate Capture
Main supply line 220V
Data transmission channels
SPEED MONITORING POINT
POLICE BACK OFFICE

Fig. 2.1 Spot SVDS

2.3.2 Section Control or Average Speed SVDS

This system measures the average speed of the vehicle over a section of road. There is no need for a speed sensor (like RADAR) as spot speed is not to be determined. Instead, cameras are placed on gantries spaced over a road section. The cameras capture the license plate of each vehicle at specific locations as shown in **Fig. 2.2**.

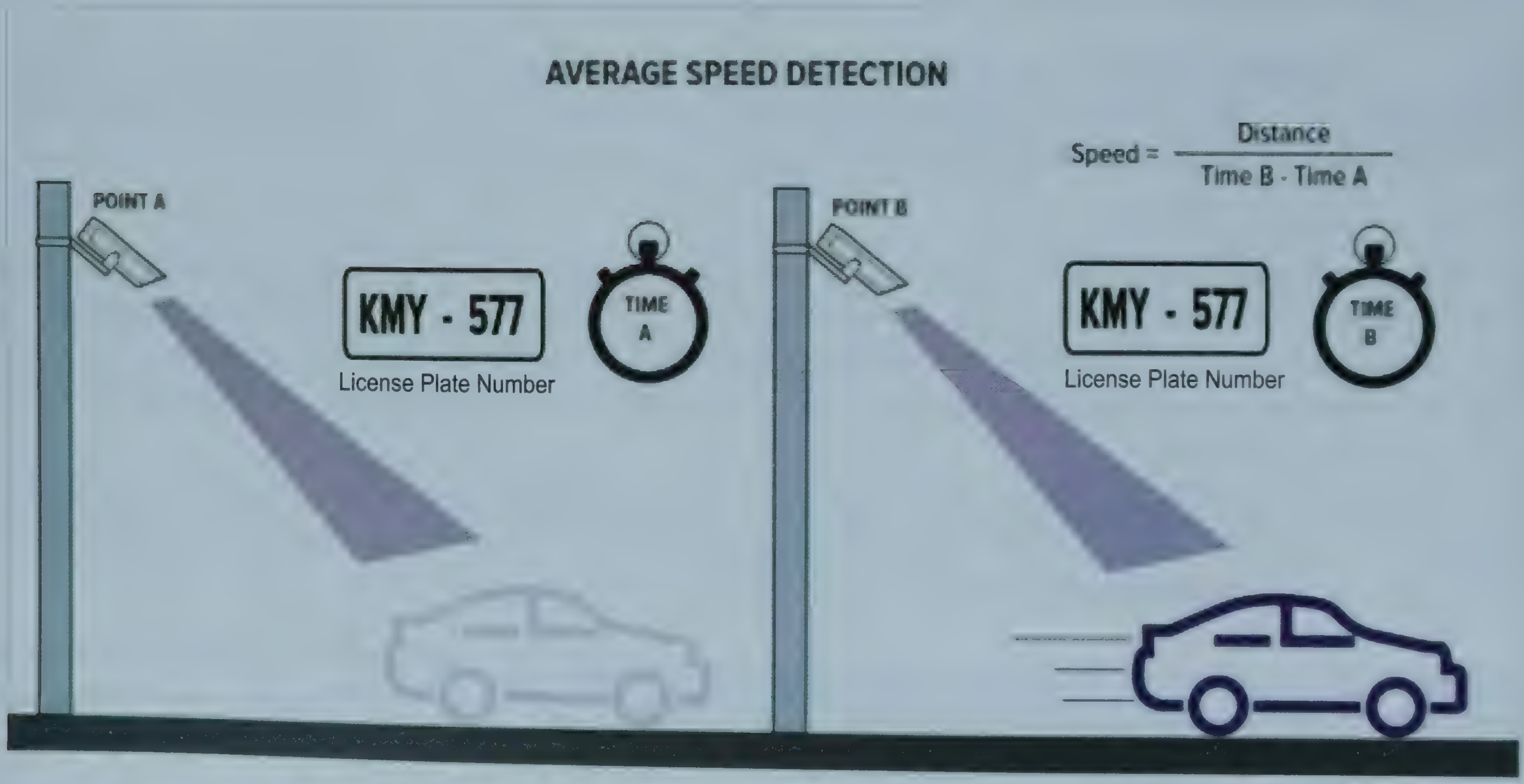

AVERAGE SPEED DETECTION
Speed = Distance / Time B - Time A
POINT A
KMY - 577
License Plate Number
TIME A
POINT B
KMY - 577
License Plate Number
TIME B

Fig. 2.2 Section Control SVDS

The road side computer records the vehicle license plate, determines vehicle class, time stamps the image and sends it to the control room. The control room receives images of the all vehicles from various locations. It matches the vehicle numbers and determines the location and time of vehicle presence at that location. Since the distance between these locations is known, the average speed of each vehicle between locations can be calculated, it may be noted that such system requires at least two camera positions to calculate average speed.

If required, the SVDS may be upgraded to additionally record spot speeds by adding speed sensors.

2.3.3 Control Room

The Control Room is to be equipped with software to record and analyse data from roadside computers, calculate speed (in case of Section Control SVDS) as shown in **Fig. 2.3**. By integrating with VAHAN database for vehicle information, it generates legally admissible evidence and present it to the Officer authorised by the Competent Authority for ratification. It shall also be capable to post the e-challan online on defined web page of the Authority.

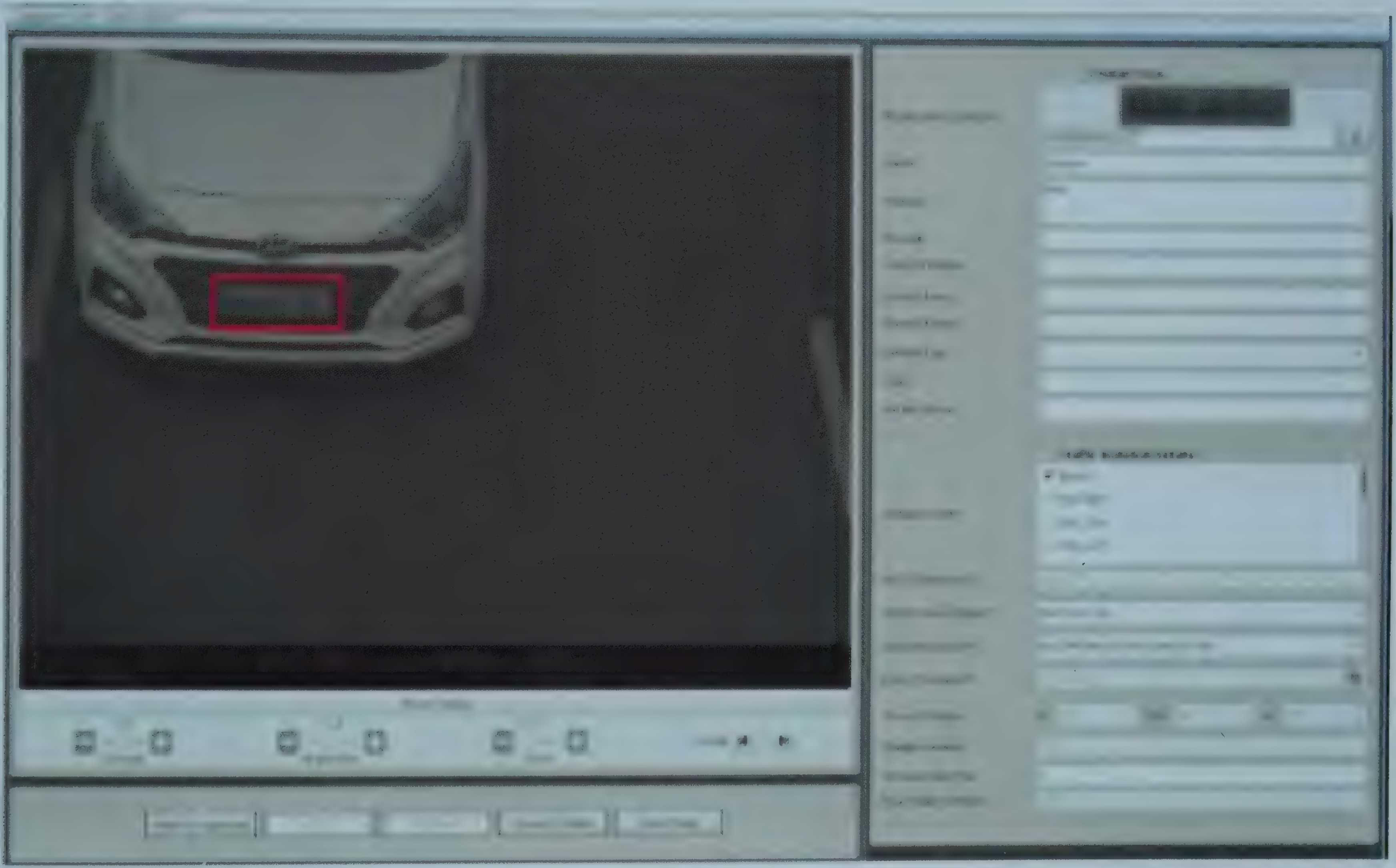
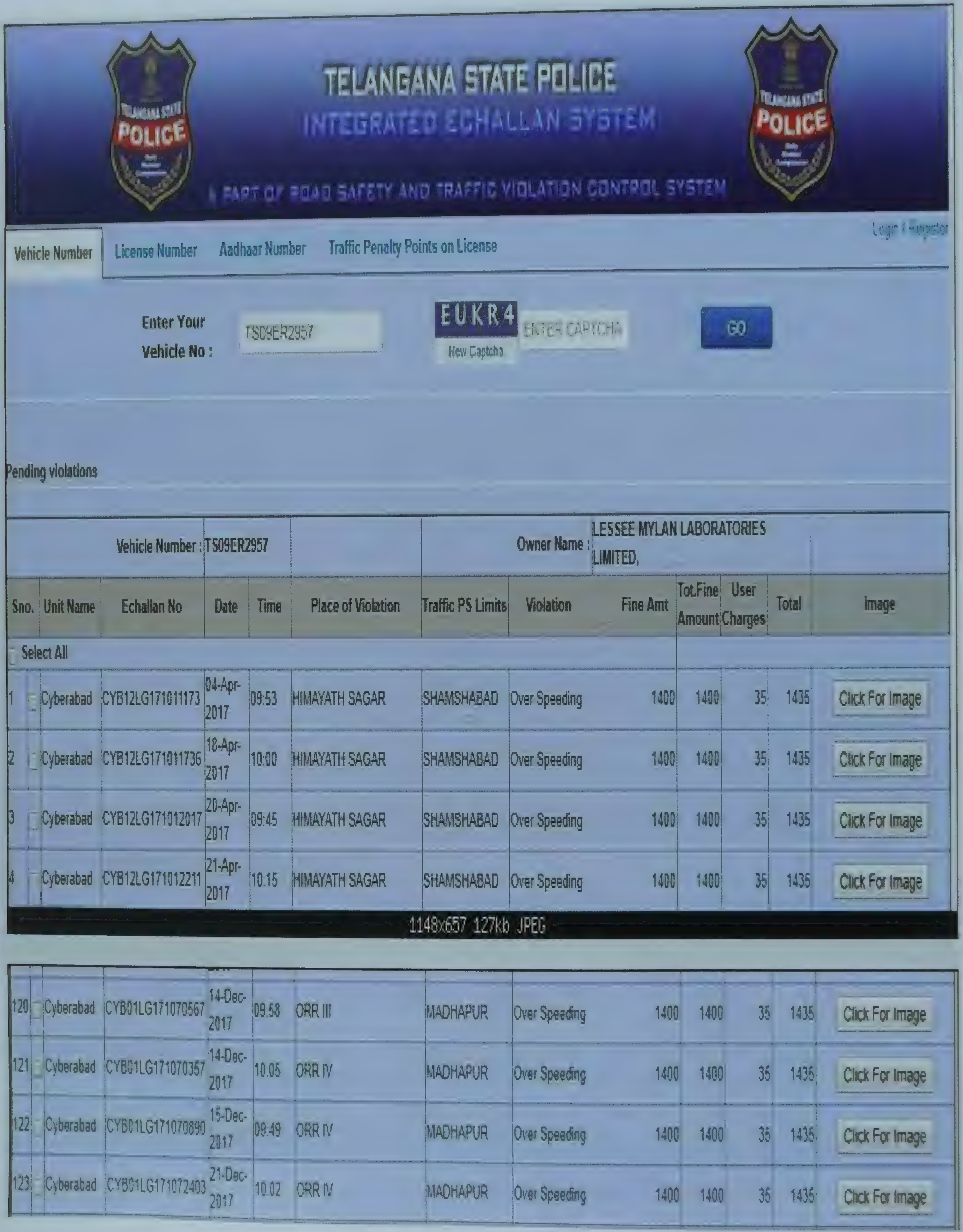


Fig. 2.3 Vehicle and License Plate image as seen in Control Room

Control room shall also have the capability to audit the data to revise or filter out incorrect data, search for specific vehicles by using filter and generate reports as shown in **Fig. 2.4**. It shall be possible to view live camera feed of the speed cameras of captured vehicles (but not an overview of entire road section). If required, additional surveillance cameras may optionally be installed for overview of road traffic and the live video feed shall be shown in the control room on a separate screen through Video Management Software.


TELANGANA STATE POLICE
INTEGRATED ECHALLAN SYSTEM
A PART OF ROAD SAFETY AND TRAFFIC VIOLATION CONTROL SYSTEM
Login / Register
Vehicle Number
License Number
Aadhaar Number
Traffic Penalty Points on License
EUKR4
New Captcha
ENTER CAPTCHA
GO
1148x657 127kb JPEG

Enter Your Vehicle No : TS09ER2957

Pending violations

Vehicle Number : TS09ER2957

Owner Name : LESSEE MYLAN LABORATORIES LIMITED,

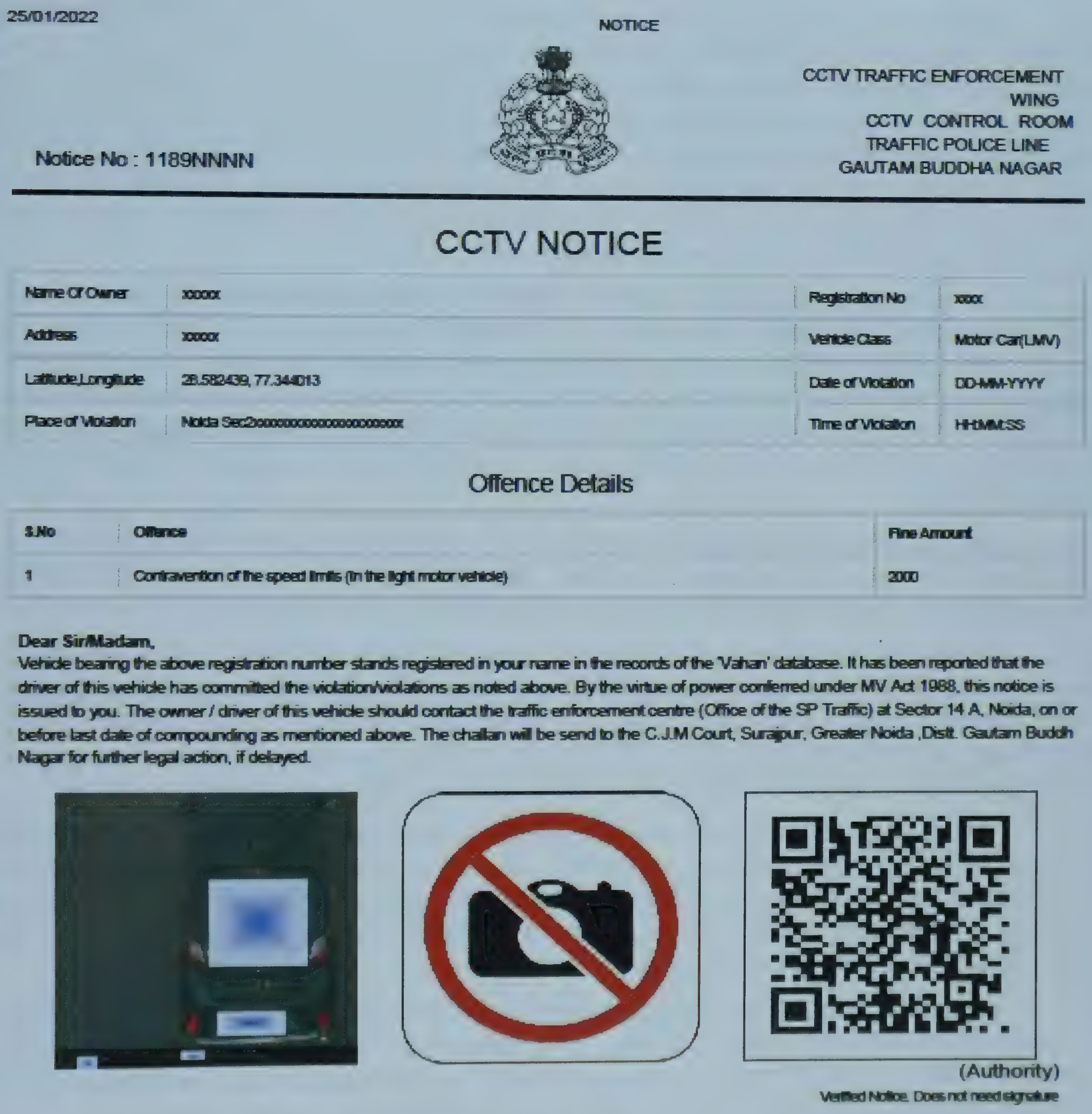
Sno.		Unit Name	Echallan No	Date	Time	Place of Violation	Traffic PS Limits	Violation	Fine Amt	Tot.Fine Amount	User Charges	Total	Image
☐ Select All													
1	☐	Cyberabad	CYB12LG171011173	04-Apr-2017	09:53	HIMAYATH SAGAR	SHAMSHABAD	Over Speeding	1400	1400	35	1435	Click For Image
2	☐	Cyberabad	CYB12LG171011736	18-Apr-2017	10:00	HIMAYATH SAGAR	SHAMSHABAD	Over Speeding	1400	1400	35	1435	Click For Image
3	☐	Cyberabad	CYB12LG171012017	20-Apr-2017	09:45	HIMAYATH SAGAR	SHAMSHABAD	Over Speeding	1400	1400	35	1435	Click For Image
4	☐	Cyberabad	CYB12LG171012211	21-Apr-2017	10:15	HIMAYATH SAGAR	SHAMSHABAD	Over Speeding	1400	1400	35	1435	Click For Image
120	☐	Cyberabad	CYB01LG171070567	14-Dec-2017	09:58	ORR III	MADHAPUR	Over Speeding	1400	1400	35	1435	Click For Image
121	☐	Cyberabad	CYB01LG171070357	14-Dec-2017	10:05	ORR IV	MADHAPUR	Over Speeding	1400	1400	35	1435	Click For Image
122	☐	Cyberabad	CYB01LG171070890	15-Dec-2017	09:49	ORR IV	MADHAPUR	Over Speeding	1400	1400	35	1435	Click For Image
123	☐	Cyberabad	CYB01LG171072403	21-Dec-2017	10:02	ORR IV	MADHAPUR	Over Speeding	1400	1400	35	1435	Click For Image

Fig. 2.4 Search Screen: Audit

2.3.4 E-Challan

The e-challan is normally presented to the road user online on the Authority's website as shown in **Fig. 2.5**. It may also be sent by post, if required by the Authority. It should have all the information in compliance with statutory requirements. In either case, the challan must be presented in required format to officer authorised by Competent Authority.

A sample challan is given below:



25/01/2022

NOTICE

CCTV TRAFFIC ENFORCEMENT
WING
CCTV CONTROL ROOM
TRAFFIC POLICE LINE
GAUTAM BUDDHA NAGAR

Notice No : 1189NNNN

CCTV NOTICE

Name Of Owner	xxxxx	Registration No	xxxx
Address	xxxxx	Vehicle Class	Motor Car(LMV)
Latitude,Longitude	28.582439, 77.344013	Date of Violation	DD-MM-YYYY
Place of Violation	Noida Sec2xxxxxxxxxxxxxxxxxxxxxx	Time of Violation	HH:MM:SS

Offence Details

S.No	Offence	Fine Amount
1	Contravention of the speed limits (In the light motor vehicle)	2000

Dear Sir/Madam,
Vehicle bearing the above registration number stands registered in your name in the records of the 'Vahan' database. It has been reported that the driver of this vehicle has committed the violation/violations as noted above. By the virtue of power conferred under MV Act 1988, this notice is issued to you. The owner / driver of this vehicle should contact the traffic enforcement centre (Office of the SP Traffic) at Sector 14 A, Noida, on or before last date of compounding as mentioned above. The challan will be send to the C.J.M Court, Surajpur, Greater Noida ,Distt. Gautam Buddh Nagar for further legal action, if delayed.

(Authority)

Verified Notice. Does not need signature

Fig. 2.5 E-Challan

3. SITE SELECTION

3.1 Site Selection Criteria

The first step of implementation is to decide the site for implementation of the SVDS. The appropriate site selection is essential to achieve the highest level of safety benefits and to ensure to the public that safety is the top priority of speed enforcement. The highest priority enforcement sites should be located where there is the greatest risk for speed-related crashes, injuries, and fatalities. The following aspects need to be considered for the selection of the site.

3.1.1 Crash risk can be determined from reliable data on crash history, crash patterns (e.g., seasonal or time of day) and other factors such as the percentage of vehicles that are speeding or nature and magnitude of traffic. Risk can also be high where there is a lack of supporting infrastructure for the type of road use (e.g., the presence of pedestrians, characterised by poor infrastructure) and high vehicular speed. It is generally unwise to select sites where risk is low because the public is likely to perceive these locations as "speed traps or black spots" However, exceptions may be made in locations with a large number of pedestrians in neighbourhoods where speeding adversely affects quality of life.

3.1.2 Complaints can also help to identify locations with speeding-related safety problems. Responsiveness to the citizen complaints' is important because citizens may be the first to notice or realise safety problems as it is related to the reduction of speed due to over-speeding of vehicles to the speed enforcement measure that is ultimately desired for the benefit of the (local) public. A site should be defined either as one specific location or as a corridor with multiple enforceable locations. In general, defining a site, a corridor can be expected to result in a more widespread benefit.

3.1.3 School zones are frequently selected as locations for speed cameras. Whereever this has occurred, the public response has been positive. High-level support might make school zone enforcement a good way to introduce speed cameras in a jurisdiction.

3.1.4 Residential neighbourhoods typically have low traffic volumes and low speed limits. Speed cameras should only be introduced at locations where speeding creates a safety problem or has a negative impact on quality of life, but within this constraint, public demand for speed management can influence site selection. It is important to have support from the residents of neighbourhoods where speed cameras are used. School zones are one such example.

3.1.5 Major roads, highways or arterials are often among the most dangerous roads in a jurisdiction, with high traffic volumes, high traffic speeds, and complex roadway geometries and traffic patterns. Speed cameras can have a significant impact on major roads, but factors such as multiple lanes of traffic and close proximity of vehicles can make it more difficult for speed cameras to single out speeding vehicles.

3.1.6 Roadwork zones often offers complex and varying traffic patterns that increase the level of safety risk for road users. Voluntary compliance with reduced speed limits in work zone is often low. Speed cameras may be especially helpful in work zones because they can be used in places where traditional enforcement methods are not feasible or hazardous.

3.2 Location

3.2.1 The next step is to decide the exact locational site where the roadside equipment shall be installed. Each direction shall be treated as a separate location. For resource optimisation, it may be better to have roadside equipment installed at the same place for both directions. However, this shall not be the guiding criteria and location shall be based on needs, fulfilment towards meeting of stated objectives and best system performance. Within a broad range of site selection (road section), the specific location (within few meters) may be decided upon site inspection. Several factors may influence it like space availability and soil suitability for gantry installation, availability of power, and safety of roadside computer from theft, vandalism & protection against vehicle hits, ease of cabling, capture of traffic with maximum accuracy, lighting considerations and availability of existing gantries or mounting structures.

3.2.2 The minimum gantry height clearance shall be as per IRC standards. The maximum height shall be decided based on criteria of best system performance and OEM suggestions shall also be taken into account.

3.2.3 The urban areas may not have long sections where traffic flow freely. This makes them more suitable for Spot SVDS. In comparison, the highways may have both spot as well as section SVDS. In case of section SVDS, the distance between two gantries should not be too less that it results in errors and not too large that it has stopping or congestion areas or exits in between which reduce average speed.

4. PROOF OF CONCEPT (PoC)

Proof of Concept stage is an important stage of implementation and is recommended for new installations.

4.1 Proof of Concept (PoC) is the evidence obtained from a pilot project, which is executed to demonstrate that the system shall work as desired.

4.2 As the implementation involves challaning the vehicles, high accuracy is required so that the evidence may be produced in court of law if necessary, The user may, at its discretion, ask for a PoC or a demonstration to verify if the system meets the requirements.

4.3 The PoC may be done in any of the following ways:

4.3.1 The user may visit another site using the same technology (including make and model of equipment) and similar functionalities under similar conditions.

4.3.2 Having the PoC at one of the finalised locations with actual proposed system components.

4.4 The objective of PoC shall be to determine if the data of speed and number plate recognition is captured and displayed accurately and meets the requirements of the System Performance. The additional requirements of the software may be developed later prior to system commissioning.

4.5 PoC is recommended when:

4.5.1 There is some change from previously demonstrated and approved system.

4.5.2 There is a new technology which has not been demonstrated to the Authority before. For example, if camera is used for speed detection instead of RADAR.

4.5.3 There is a change in make/model of key equipment or software platform change from previously demonstrated system.

4.5.4 Or if there is change in equipment position which may change the system output. For example speed measuring equipment like IR or RADAR is placed on side of the road, instead of being gantry mounted.

It is recommended that the Authority always have a PoC whenever there is some change from an approved system or there is not sufficient confidence or experience in the proposed system.

4.6 The PoC shall also enable new technologies /vendors /components to be adopted and approved by the Authority. PoC shall also help define any new requirements.

4.7 The PoC shall include Key Components which shall be of the same make and model as that proposed in the actual system. These shall include at least the following:

a) Speed sensor

b) Speed camera

c) Local computer fitted inside cabinet

d) Switch/router

4.8 The PoC must meet the Success Criteria set by the Authority. Some of the Success Criteria are:

4.8.1 Accuracy parameters defined in Performance Parameters

a) Vehicle speed accuracy

b) Vehicle category /class accuracy

c) Number-plate image capture accuracy

d) OCR accuracy of conversion of number-plate image to text

4.8.2 Control room software

a) Display of over/under-speeding vehicle images

b) Sample e-challan generation

c) Live feed viewing

d) Audit functionality

4.9 The Authority shall decide the PoC duration and methodology for test and approval. The test methodology suggested in the section of Performance Parameters may be used.

5. FUNCTIONAL REQUIREMENTS

The system shall meet the Functional Requirements given in this section at all times. The Technical Specifications are recommended as performance guidelines in **Annexure**. Different Technical Specifications may be allowed as long as they meet Functional, Statutory and other requirement mentioned in this document.

The system shall meet the following Functional Requirements:

5.1 Road-side local computer shall be fan-less industrial grade and housed in a sturdy, vandal resistant and weather resistant cabinet, to be placed in safe place.

5.2 The field equipment shall be mounted on overhead gantry or roadside.

5.3 Control Room software shall include application software, operating software, database software and any other software required to meet functional requirements. The proposed system should have the capability to transfer the data to Central Command Centre through proper encryption of data in real time. Proposed application for speed violation detection system should adhere to National Cyber Security Policy to ensure that the critical information processed and stored by the proposed application is to secure from cyber-attacks /hacking / hijacking.

5.4 Communication

5.4.1 **Communication Media :** it may include optic fibre, copper cable, GSM (4G or above), radio or satellite link.

5.4.2 **Transmission Equipment :** consists of switch, router, modem, radio station etc.

5.4.3 **Power :** it includes Power source (SEB, diesel generator, solar power etc.), UPS and batteries, surge protection, earthing, lightning protection and any other power conditioning equipment.

5.4.4 **Other Equipment :** includes all necessary cables, connectors, mounting arrangements, software, monitoring and test equipment and any other equipment required to maintain and keep the system running to achieve intended functionality and performance requirements.

5.5 Working

The system shall consist of field equipment and back end/control room equipment and communication media. Field equipment shall consist of sensors to measure vehicle speed, category of vehicle and any other parameter defined in the functional requirements. A roadside computer shall collect sensor inputs and process this data which may then be sent to control room for further processing.

5.6 The system shall capture the data of the following parameters :

a) Vehicle Speed

b) Vehicle Category

c) vehicle number plate clear image (readable by human eye)

d) clear vehicle image showing complete or at least identifiable section of vehicle

e) Time Stamp (time and date)
f) Location ID and location name
g) Lane ID or name

5.7 The roadside computer shall generate a "transaction" containing all above parameters. Each transaction shall have a unique ID. The transaction shall be printable on one A4 size paper. All images stored in the system shall be watermarked with transaction ID, date, time and location. Sufficient number of cameras and other sensors shall be installed to cover all lanes, including shoulders, if any. If required, these should have continuous live video feed from all cameras which shall be shown in the control room. This live feed shall not be recorded, unless specifically asked for. The roadside computer shall record still image for all vehicles and video of at least 3 seconds before and after transaction for of all violation vehicles. Computer has sufficient memory to store 7 days of data. This data shall be sent to the control room computer. However, if the communication link does not have sufficient bandwidth, it shall be possible to set the roadside computer to the following conditions:

5.7.1 Record images (ANPR and vehicle) of over/under-speeding vehicles only.

5.7.2 Record video of specified duration (default : 3 seconds), for over/under-speeding vehicles only.

5.8 For Section control system, the distance between image capture points shall be measured accurately. The proof or reading and measurement methodology shall be submitted to the Competent Authority.

5.9 The system shall also record the location which shall have the following attributes: location name, lane ID, chainage (for highways), direction of travel (LHS or RHS) and GPS coordinates.

5.10 System shall maintain correct time and shall ensure that all roadside computers are synchronised with the control room computer using Network Time Protocol (NTP). The control room computer shall be set to correct time using GPS clock. The synchronisation shall take place at least once a day and the time drift shall not exceed 1 second. In case the network connection breaks, the roadside computers shall update its time using in-built GPS clock.

5.11 The system shall operate in day and night conditions as well in low visibility.

5.12 The system shall have a provision to send instant SMS messages to registered vehicle owners (as in VAHAN database) in case of vehicle speeding outside set limits (over/under-speeding).

5.13 The system shall have vandal detection feature. In case of any attempted vandalism of the roadside cabinet, the roadside equipment shall alert the control room. The roadside cabinet shall alert the control room when a) the door is opened b) there is attempt to remove or break the cabinet (vibration and shock sensors may be installed)

5.14 **Optional Equipment :** If required by the Authority, for additional security and surveillance, the following may be provided :

5.14.1 Surveillance Camera : this camera shall monitor the specified road section and /or the equipment provides overview of road traffic. It shall be a PTZ camera with at least 30x optical zoom. These cameras shall have inbuilt memory card to continue recording even if connection with control room is broken.

5.14.2 Motion Detection Camera : Motion detection camera is used which a separate camera with motion detection capability shall be provided to monitor the roadside cabinet and if possible, other equipment. Within the field of view of the camera, it shall be possible to define the area for which the motion detection is required. When any motion is detected in this area, the camera's in-built software shall raise alert in the control centre as soon as any movement is detected near the cabinet and camera pole, to alert the control centre operators regarding any possibility of pilferage and vandalism attempt. The face detection function shall be activated as soon as the motion detection is triggered. The camera shall also detect any object addition, object removal, and line crossing. Whenever any event is triggered, the camera shall record the event on SD card also. The camera shall be mounted on 1m cantilever arm attached to the pole. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

5.14.3 Control Room Equipment : The camera feed shall be recorded in control room computer/NVR/DVR. The surveillance system shall be independent of the speed detection system. There shall be a separate control room computer, software, monitor and keyboard for these surveillance cameras.

5.14.3.1 The camera and hooter beacon alarm shall be installed at height of 8m to prevent vandalism.

5.15 The speed limit shall be configurable in the software for each category of vehicle. The following should be adhered to ensure accuracy of the measurement. The system shall be able to meet the following accuracy levels as defined in section dealing with Performance Requirements. Control room software shall be able to process from stored data, search transactions by

a) vehicle number

b) date and time range

c) transaction ID

d) over speeding vehicle

e) blacklisted vehicle

f) vehicle category

5.16 Data Processing : The roadside sensor shall record the sensor data (camera and speed sensors). The processing of the camera and speed sensor data may take place in roadside unit or at the control room. If a good and reliable communication network is not available then the roadside equipment may process the data and send only the over-speed/under-speeding transactions to the control room. The processing of data can be made through standalone mode.

5.17 Standalone Mode : It shall be possible to install the application/processing software on a laptop which can be connected to the roadside computer to directly transfer data to laptop for processing. This shall be used when communication link between site and control room is broken. The software shall have the following modules.

5.18 **Viewing & Audit :** The control room software shall allow live viewing of one or more cameras. The captured image shall show the captured vehicle on the display screen along with its category and speed (speed only for spot SVDS) by highlighting each captured vehicle. It shall be possible to see the image of any vehicles detected by the system but number-plate is not captured, by naked eye on the screen. It shall be possible for audit module to show any recorded video section of transaction in slow motion so that the vehicle that needs to be captured for accuracy can be manually determined. The audit module shall have option to show all or specific transactions after applying the software filters by selecting parameter range through a drop down menu. It shall be possible to view transaction image and manually correct the following parameters: with respect to vehicle category, vehicle number.

5.19 The system software shall provide an option to a settable speed tolerance, "x". No vehicle shall be penalised if the detected speed is "x" above the permissible limit. The initial system value shall be 5kmph, unless specified by the competent authority. It shall be possible to change this any time, if as authorised by the competent authority.

5.20 The system software shall be integrated with VAHAN software and database of the Government of India. The user shall obtain necessary approvals and integrate the system with VAHAN database.

5.21 The SVDS central software shall be capable of generating e-challan automatically and integrated with the VAHAN database, NIC, ITMS, and NPCI, FASTag mapper for obtaining the vehicle registration and contact details for e-challan and cross-verification of the vehicle class. The NIC, ITMS, and NPCI, FASTag represents NIC, National Informatics Centre, Integrated Traffic Management System, National Payments Corporation of India and FASTag respectively.

5.22 **E-challan Module :** The module shall have the following:

5.22.1 The system shall generate e-challan in format and language approved by State Government with provision to contain the following:

i) State Transport Authority Logo, National Emblem, relevant Motor Vehicle Act section,

ii) Vehicle Owner Information – Name, Father's name, Address as per records in VAHAN database

5.22.2 It shall have provision to be verified or signed by authorised officer of state prior to issue of challan.

5.22.3 The challan shall have the following minimum information:

- Challan number
- License plate number (in text)
- Date and time of violation
- Location of offence (spot or stretch location)
- Details of violation with observed speed in km/hr
- Amount of penalty
- Two images – i) license plate and ii) vehicle
- Standard text – as approved by state traffic police and space for signature, if required.

5.23 In addition, the system shall record and store video of the vehicle "x" seconds before and after the incident for validation in case of dispute. The "x" shall be settable (up to 10 seconds) with default setting of 3 seconds

5.24 Reporting

It shall be possible to draw various reports and view them on computer, print on printer, export to excel and pdf. The reports shall be:

5.24.1 Statistical Reports : these are reports showing operations statistics like traffic volume. Filters - The system shall be able to draw traffic volume reports with the following filters:

- Date and time range
- vehicle number – last 4 digits, exact match
- RFID tag ID (if installed)
- Lane
- Vehicle category
- Location
- transaction ID
- over-speeding vehicle – over-speeding by x% where x is a settable parameter
- blacklisted vehicles
- vehicle category

5.24.2 System Reports : these reports show system statistics like user and access list, login/ logout data, unauthorised access, system alarms etc.

5.24.3 Maintenance reports show system downtime.

5.25 **Challan Module :** the system shall also provide functionality for traffic police to issue challan in the format decided by them.

5.26 **Power** : The field equipment, communication backbone and control room equipment shall be provided with independent standby power for uninterrupted functioning. The standby power shall be sufficient for 4 hours of uninterrupted functioning on full load at all times.

5.27 **Communication :** the user/concerned agency shall provide communication link between roadside computers and the control room. Ideally this shall be through an optic fibre link. OFC switch shall be housed in the roadside cabinet. If this is not feasible, the contractor may propose wireless or leased line link, whichever is feasible. The system shall also have connection over GSM (minimum 4G). In case the primary link breaks, the system shall automatically shift to this.

5.28 **Time Synchronisation :** all field computers shall be time synchronised with the central computer, at least once a day or if the drift is more than 1s.

5.29 Software shall be access controlled. No user shall access the system without username and password. All logins shall be recorded. The Administrator shall have the highest authority and shall be able to perform the following functions:

5.29.1 Create, edit, and delete users

5.29.2 Initialise users – assign username and initial password

5.29.3 Create user groups and grant access levels

5.30 **Remote access :** it shall be possible to access the system functionalities through a remote computer through a web interface. Any authorised person shall be able to login with valid credentials using a commonly used web browser like Google Chrome, Mozilla Firefox, or Microsoft.

5.31 A Maintenance Module (MM) shall be included in the system software. The user/concerned agency shall record all system maintenance history and spare part tracking in this.

5.32 Statutory Compliances

5.32.1 Equipment approval at time of issue and its periodic approval shall comply with requirements of MoRTH Gazette Notification G.S.R. 575(E) dated 11th August 2021.

5.32.2 Challans format shall be as per of above mentioned notification.

5.33 **Interoperability :** It is possible that multiple systems (by multiple users/concerned agencies) are installed in the state. The state agency (traffic police) may require the data in a form, using which, speed violations between adjacent speed monitoring sections may be used to detect violators. This shall require that speed (time and location) record of one section be passed to adjacent section. For this, the data, as mentioned above shall be transmitted to central control room, if any, in XML (Extensible Mark up Language) format. The same shall be followed by central road agencies such as NHAI. The exact XML format shall be decided by the state or central agency.

6. PERFORMNCE REQUIREMENTS

It is imperative to ensure that the SVDS functions as per the various requirements as explained in the preceding section before we undertake to examine various aspects of performance requirements of the system. There are a number of parameters for which performances of the system are required to be checked are discussed below in the **Table 6.1.**

6.1 Performance:

The system shall, at all times, meet the Performance Requirements as given below:

Table 6.1 Performance Requirements of SVDS

Parameter	Compliance range	Measurement method
Vehicle capture accuracy	>98% of the all the vehicles on road	This shall be verified by monitoring traffic for a 15 minute interval, in day as well as night/low light conditions, either manually or in control room. Measurement frequency : once a month
Vehicle speed	Vehicle speed detection accuracy shall be > 99% for speeds up to 220 kmph	For spot SVDS, this shall be verified manually against a speed gun using a test vehicle. For section SVDS, this shall be verified by simultaneously checking the system generated time of each location. Measurement frequency : once a month
Vehicle category	>95% of the total vehicles captured/ detected	This shall be verified by monitoring traffic for a 15 minute interval and by using audit tool of the vendor. Measurement frequency : once a month
Number platecapture accuracy (of the vehicles detected)	Image capture > 95% OCR > 90% for all vehicles with non-HSRP numberplate OCR > 95% for HSRP vehicles	This shall be verified by monitoring traffic for a 15 minute interval and by using audit tool of the vendor. Measurement frequency : once a month

Parameter	Compliance range	Measurement method
Power backup (control room and roadside equipment)	Minimum 4 hours on full load	This shall be measured manually by switching off mains power supply. Measurement frequency : once every three months

6.2 The system shall be able to meet the above accuracy levels for vehicular speeds under conditions mentioned above. In addition to above, the equipment shall be approved periodically as per MoRTH Gazette Notification G.S.R. 575(E). dated 11th August 2021 (see point 2)

6.3 The accuracy levels mentioned are the minimum requirements and system shall always meet the statutory requirement of the state and any enhanced special project requirements.

6.4 **Image Camera :** The vehicle as well as number-plate image shall be clearly captured the number-plate as well as vehicle image. The number-plate in image shall be readable by naked eye without any ambiguity or doubt. The system shall be able to capture clear images in all light and weather conditions. If required, IR illuminators shall be deployed, as required.

6.5 **Speed Sensor :** The speed sensor shall accurately capture the spot speed in all light and weather conditions.

6.6 Power

6.6.1 The field equipment shall have a power backup of 4 hours on full load.

6.6.2 The control room equipment shall have a power backup of 4 hours on full load.

6.6.3 Earthing shall be as per IS: 3043 or as recommended by OEM. Separate digital and electrical earths, if recommended by OEM.

6.7 Structural

6.7.1 The gantries and mounted components shall be able to withstand wind speed of 180kmph as well as conform to the seismic requirements of the zone where it is installed. A certificate from an approved structural engineer shall be submitted.

6.7.2 There shall be no effect of road vibrations on the system performance and accuracy.

7. OTHER REQUIREMENTS

In addition to the various components discussed above, other requirements such Environmental, Installation Documents, Operational Manual, System Manual, Maintenance Manual, Training Needs, Standards certification and Compliances etc. need to be understood clearly so that the user can handle the system effectively as mentioned as under:

7.1 Environmental

7.1.1 The system shall work without any degradation in all environmental (temperature, humidity, precipitation) and seismic conditions.

7.1.2 CENELEC EN 60529: Degrees of protection is provided by enclosures (IP code –IS/IEC 60529). All outside enclosures exposed to the elements shall be protected to IP65 in terms of this standard.

7.1.3 For ambient conditions, last 10 years of data shall be considered and the system shall be designed considering the extremes observed condition during this period.

7.1.4 If any equipment does not comply with the ambient conditions, the surrounding atmosphere shall be modified to match the equipment's environment range. This shall be particularly applicable for equipment installed indoor with air-conditioning.

7.2 Installation Documentation

Installation methodology shall be developed as a "Method Statement" document and to be submitted to the Competent Authority for approval. The Method Statement shall include:

7.2.1 The installation methodology for each OEM item like camera, RADAR, roadside computer, power supplies.

7.2.2 Methodology related to installation related to equipment other than OEM like – cables, connectors and joints, cable numbering, earthing, lightning protection

7.2.3 List of compliance to Standards for each of above

7.2.4 Safety precautions including safety gear and tools for workmen. Safety zone precautions for public. Procedure for response to emergencies.

7.2.5 Quantity, location, make and model of each equipment

7.2.6 Methodology shall also include diagrams, designs (like foundation and civil works, cable layouts), illustrations and flowcharts to make the reader understand the process better.

7.3 Operations Manual

The Operations/User manual shall be developed to facilitate ease of Operations. It shall describe at least the following:

7.3.1 The organisation structure – organogram, designations, list of personnel, escalation matrix . Escalation matrix shall have a list (name, contact details) of personnel to escalate an unresolved issue.

7.3.2 Operations Methodology

- **Working Methodology** : step by step working of system, functioning of each menu option, screenshots and workflows so that the each of the system users may easily operate it

- role and responsibility of each personnel
- access level
- control and monitoring methods
- safety and security of personnel, data and assets

7.3.3 An annexure providing contact numbers and emails of personnel in escalation matrix. This shall be updated whenever there is any change in details or when Operations Manual is revised, whichever is earlier.

7.3.4 Annexure containing the formats used for Operations.

7.3.5 The Operations Manual shall be revised annually after receiving feedback from the stakeholders.

7.4 Systems Manual

It shall define the system design and technical specification, as implemented in the project. It shall include at least the following:

7.4.1 Equipment communication interconnection diagrams and data calculations.

7.4.2 Equipment power interconnection diagram and power load calculations.

7.4.3 OEM (Original Equipment Manufacturer) brochure and datasheets describe functionalities, technical specifications and data structures for each component – hardware as well as software.

7.4.4 Documentation explains how the system shall comply with requirements with help of flowcharts, description of transaction/vehicle passing, data flow within and outside the system, data recording, data security and audit.

7.4.5 Compliance to Standards and Specifications should be follwed strictly.

7.4.6 Structural diagrams and design calculations for civil structures (gantries, poles, foundations)

7.5 **Maintenance Manual** – It shall contain the following sections:

7.5.1 Organogram/organisation chart, list of authorised personnel, access levels, escalation matrix.

7.5.2 **Preventive Maintenance :** This includes the periodic maintenance of the system even if there is no system breakdown or error reported. It shall contain the following:

- Annual Preventive Maintenance Schedule for approval by competent authority.
- Maintenance check-sheet shows equipment location, name, serial number, test/ maintenance to be performed, tools to be used, safety measures to be followed, approximate time duration for each activity, status of each test/maintenance activity.
- A summary report at end of each scheduled maintenance activity shows corrective action to be taken, if any.

7.5.3 **Breakdown Maintenance :** Breakdown maintenance shall be undertaken when there is a deviation from intended performance or form. This shall include

- Methodology for fault reporting
- Spare parts/defective parts tracking system
- The maintenance activity details as well as parts management shall be inputted in the Maintenance Module.
- The system shall automatically calculate the downtime and applicable penalties if required uptime is not achieved. This shall be made available in a report.
- The system shall also have a provision to calculate applicable penalties in case the performance standards are not met. For this, the system shall have a provision to input the actual performance measured as per "Measurement Method" defined in **Table 6.1** Performance Requirements of SVDS. This shall be made available in a report.

7.6 **Training :** It is important to ensure that the Operations team as well as Authority's staff should be imparted in-depth training of the system. The trainer shall provide sufficient operation and maintenance training such that the key personnel become fully conversant with the contents of the equipment and equipment working. Training program shall be prepared and presented to the Authority for approval.

7.6.1 The training shall include in-depth series of sessions which shall comprise of both classroom type.

7.6.2 **Training as well as Practical Training :** The training shall be specific to both classes of personnel, these being Operational and Maintenance personnel. The agency shall supply all training materials and conduct the training to satisfy the users. This shall conduct post-training test along with the issuance of Training Certificates.

7.6.3 The training programme shall comprise of the following minimum requirements:

- A start up program detailing the purpose, usage and functionality of the integrated system/s (practical and theory training).
- A program detailing the functions and specific features of each sub-system and its associated equipment components (practical and theory training).
- A program detailing the operation, administration and maintenance of the equipment components, sub-systems and integrated system (practical and theory training).
- The equipment manuals shall be referenced and utilised during the training sessions.

7.7 Standards, Certifications and Compliances

7.7.1 The system & equipment shall comply with the one of the following Standards in the following order of precedence. To clarify, if a higher standard is available, lower standards shall not be referred to.

- Indian Standards /BIS
- European Standards (EN/CEN/CENELEC)
- British Standards
- American Standards
- Japanese Standards
- Any other Global and commonly accepted industry standards

7.7.2 The equipment shall comply with applicable Standards for at least the following parameters:

- Electromagnetic Interference (EMI)
- Equipment Safety - Low and High voltage, Radiation, LASER
- Weather proofing
- Withstanding vibrations
- Standards for Data Interchange
- Staff Safety and Hazardous Substances
- Seismic compliance for Applicable Zone
- Structural Standard for Gantry and any Other Civil Structure

8. IMPLEMENTATION

After the Authority has notified the selected site, the choice of system shall be defined i.e. Spot Speed Average Speed control or both. The following shall be the process for system implementation:

8.1 Installation

8.1.1 Prior to commencement of works, plan and checklist of works shall be submitted to the Authority based on which the progress shall be periodically reviewed. Method Statement approved by the Authority shall be strictly followed and relevant records shall be maintained for each stage of implementation. Any documentation required for operationalisation, like power connection certificate, equipment test & compliance certificates, statutory obligations etc., shall be submitted to the Authority.

8.1.2 Exact location within the site shall be finalised and marked on ground. This shall include - defining location (chainage and GPS coordinates) of the gantry, roadside computer, communication equipment and optional items. The location of such points shall be submitted to the Authority as part of records.

a) All designs, documents and drawings shall be approved by the Authority prior to installation.

b) The gantry design shall ensure that it can withstand road vibrations and is of height as per IRC/state guidelines and is compliant to local seismic requirements. The performance of equipment shall not be affected by vehicular vibrations.

c) Equipment shall be installed so as to minimise chances of vandalism and theft. The foundations for road mounted equipment/poles shall be as per OEM recommendations.

d) **Civil and excavation works :** It shall be ensured that lane closure and safety procedures /traffic management plan during construction are followed during installation. Approval from concerned authorities shall be obtained prior to commencement of work.

e) **Power and Communication :** data and power load calculation shall be submitted to the Authority. Provision shall be kept for future expansion and addition of equipment.

f) **Inspection :** The activities may be inspected from time to time during installation. The following shall at least be checked:

   i) Cables and connectors

      1) Cable joints and terminations shall not be loose, cable cuts and joints shall be avoided to the extent possible

      2) Cable numbering system shall be followed, numbering shall be done using ferrules.

      3) Cables shall be encased in conduits. GI pipe conduits shall be used for road crossing, otherwise PVC and flexible conduits may be used.

   ii) Mounting of equipment : Mounting brackets and fasteners shall ensure that equipment is secured to the mounting pole/gantry and the equipment does not vibrate or remain loose. The nuts and bolts shall be rust resistant and shall be greased so that dismantling /removal is easy during maintenance.

iii) Equipment is installed as per Method Statement and OEM guidelines.

iv) If power is drawn from State Electricity Board, the copy of power connection document shall be furnished. The power cabling and joints shall be inspected for open joints or cable cuts. The risk of electric leakage and shock shall be minimised and protections like fuse and safety alarms shall be ensured.

8.2 **Installation Acceptance Test :** The equipment shall be tested for correct installation. The equipment shall be powered on and checked if all equipment is working. All earthing, cabling, conduiting, mounting and physical appearance shall be checked visually and/or by testing equipment. Conformance of equipment to approved Technical Specifications shall be checked through visual inspection and/or OEM brochure/data sheet/compliance letter. However, functionalities shall be tested during System Testing stage.

8.3 **Factory Acceptance Testing (FAT) :** The equipment hardware and functionalities shall normally be tested on site during System Testing. However, if the Authority intends to verify any equipment beforehand, it may ask for a test at the factory, prior to despatch. The purpose of such FAT is to build with reasonable confidence that the system shall work at site. The FAT is normally undertaken on the system software to check if the software has been developed to meet the requirements. However, if the Authority decides to test any hardware, it may specify it to be tested at the place of manufacture. The results of FAT shall be noted on the FAT check-sheet including the PASS/FAIL status.

8.4 **System Testing :** Once the installation inspection is approved and all necessary documents compiled and submitted, the system shall be tested for functionalities. If Proof of Concept has been conducted earlier, the results shall be reviewed and any observation noted during the PoC shall be checked during system testing. The following shall be tested as a minimum:

8.4.1 Each equipment individually works on site as per requirement and OEM guidelines, if not tested during FAT or PoC.

8.4.2 The system software complies with the Functional Specifications. The functionality of each component shall be tested and the result recorded in the System Testing check sheet.

8.4.3 The system is able to meet the Performance Requirements and after that, the system performance should be acceptable.

8.4.4 The system shall be made operational if it meets all the key parameters approved by the Authority. The authority may decide to make the system operational even if some minor issues occur which do not affect system performance. It remains like modification in a system report.

8.5 **System Commissioning/Acceptance :** After operationalisation, the system shall be put to work for a period of time till it becomes stable and give consistent and accurate results. This trial period may be from 1-3 months and no challans shall be sent to road user during this period. Commissioning shall happen when the system meets all the Functional, Statutory, Performance and Other Requirements mentioned in this Manual. If the system passes all requirements, the system shall be deemed to be commissioned and accepted and actual challaning can commence. The system shall now be deemed to be in Operations and Maintenance phase and project closure for implantation shall happen.

8.6 A Project Closure Manual shall be prepared and submitted to the Authority. It shall include at least the following:

a) As built drawings
b) Copy of all document of statutory compliances
c) Software licenses
d) Equipment inventory and location
e) Issues faced, solutions implemented and lessons learnt
f) Project photographs, samples given below:

Photo 8.1 Average Speed Cameras installed on Expressway

Photo 8.2 Spot Speed : 4D Imaging RADAR with camera and IR

Photo 8.3 Validation by Traffic Police at Control Room

9. MEASURING EFFECTIVENESS

Effectiveness of Speed Violation Detection System (SVDS) is typically measured in outcomes related to speed or collisions. It is suggested that the Authority offers a measure of defined parameters before and after implementation of the Speed Violation Detection System (SVDS) so that effectiveness of such system be measured and benefit/cost ratio be determined. Some parameters of measuring effectiveness may be:

a) Reductions in average speed
b) Percentage of vehicles speeding over legal limit
c) Number or rate of crashes stratified by severity
    - property damage only,
    - injury, or
    - fatality.
d) Ratio of actual number of challans generated to violations detected by system.

Though the objective of the Speed Violation Detection System (SVDS) is not to generate revenue, a cost/benefit analysis in monetary terms may be undertaken. For this, the system cost (capex+opex) may be compared with the revenue generated through violations.

10. REFERENCES

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2. https://vahan.nic.in/nrservices/
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4. "The Effectiveness of Speed Cameras : A review of evidence" by Richard Allsop, 2010 https://www.racfoundation.org/assets/rac_foundation/content/downloadables/efficacy_of_speed_cameras_allsop_181110.pdf
5. https://www.roadsafetyfacility.org
6. https://www.team-bhp.com/forum/road-safety/197118-honda-jazz-hyderabad-accrues-rs-1-8-lakh-overspeeding-fines-year.html
7. https://timesofindia.indiatimes.com/business/india-business/automated-red-light-and-speed-violation-detection-systems-unveiled-in-delhi/articleshow/68199769.cms

Annexure

TECHNICAL SPECIFICATIONS

The following Technical Specifications are recommended as a guideline, for major components. The implementation may choose different Technical Specifications as long as they meet Functional, Statutory and other requirement mentioned in this document.

1. RADAR

Detection Range	Up to 300 m
Frequency	76-81 Ghz
Number of vehicles that can be tracked simultaneously	More than 50
Measurement parameters	Range, azimuth, elevation, speed
Speed detection	220 kmph
Speed accuracy	± 1%

2. Camera (ANPR)

The following are the suggested for camera used for Automatic Number Plate Recognition.

Resolution	1920x1080 (2 MP) or better
IR-cut Filter & Day/Night	Yes
Headlight filter design for Anti-Glare	Yes
Minimum Illumination	0.01 Lux (colour)

3. Camera (Speed detection)

The following are the suggested for camera used for speed detection, if implemented.

Type	Global Shutter
Maximum Resolution	2048 x 1536 (3 MP) or Better
Day/Night function	Removable IR-Cut filter for day & night function
Anti glare	Headlight filter design for Anti-Glare

(The Official amendments to this document would be published by the IRC In its periodical, 'Indian Highways' which shall be considered as effective and as part of the code/guidelines/manual, etc. from the date specified therein)

Price : ₹ 300/-
(Plus Packing & Postage)